

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

REMARKS

By this amendment, new claims 40-41 have been added in the application. Currently, claims 3, 5, 7, 9-41 are pending in the application.

Claims 3, 5, 7 and 9-39 were rejected under 35 USC 103(a) as being obvious over Kawakami et al. (JP 1-242782). Also, claims 3, 5, 7 and 9-39 were rejected under 35 USC 103(a) as being obvious over Kawakami et al. in view of Weber et al. (U.S. Patent No. 6,274,241). Further, Claims 3, 5, 7 and 9-39 were rejected under 35 USC 103(a) as being obvious over Kawakami et al./Kawakami et al. in view of Weber et al./, further in view of Segawa et al. (JP 2001-316834).

These rejections are respectfully traversed in view of the enclosed Declaration under 37 CFR 1.132 showing the differences with the prior art to Kawakami et al. and Weber et al. and the remarks below.

The present invention relates to a conductive electroless plated powder and a method for making the same. More particularly, the present invention relates to a conductive electroless plated powder provided with nickel films having improved heat resistance (see page 1, lines 7-11 of the specification).

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

In the nickel film of the plated powder of the present invention, many columnar structures extending in the direction of the thickness gather tightly to form a dense, homogeneous, and continuous film as shown in Fig. 1. On the other hand, in the nickel film of the conventional plated powder shown in Fig. 2, the crystal grains are rough and heterogeneous. The present inventors have found that, in the nickel film having the columnar structures as shown in Fig. 1, unexpected results have been found which include that the heat resistance is high and the conductivity of the plated powder is not really decreased even under high temperature conditions (see page 5, lines 9-19 of the specification).

The present invention discloses that the initial thin film formation step is carried out to deposit nickel uniformly on the core particles and to smooth the surfaces of the core particles. In the initial thin film formation step, first, the core particles supporting the noble metal are dispersed in water thoroughly. A shear dispersing machine, such as a colloid mill or homogenizer, may be used for the dispersion. When the core particles are dispersed, for example, a dispersing agent, such as a surfactant, may be used as necessary. The aqueous suspension thus prepared is mixed and dispersed in an initial thin film-solution containing nickel ions, a reducing agent, and a complexing agent composed of an amine. Thereby, the reduction of nickel ions is started, and nickel initial

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

thin films are formed on the surfaces of the core particles. Since the initial thin film formation step is carried out to deposit nickel uniformly on the core particles and to smooth the surfaces of the core particles, the resultant initial thin nickel film only requires a small thickness which enables smoothing the surfaces of the core particles (see page 11, line 12 - page 12, line 2 of the specification).

The present invention also discloses that it is important to involve a complexing agent in the initial thin film-forming solution. By incorporating the complexing agent in the initial thin film-forming solution and by incorporating the complexing agent in the nickel ion-containing solution, it is possible to form a nickel film having columnar structures (see page 12, lines 20-26 of the specification).

Independent claims 3, 16, 33 and 34 recite "(II) dispersing the core particles in an initial thin film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an amine to prepare an aqueous suspension, and reducing the nickel ions to form initial thin nickel film on a surface of each of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent, to the aqueous suspension individually and simultaneously, the aqueous suspension containing

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

the core particles provided with the initial thin nickel films and the complexing agent to perform electroless plating so that columnar structures extending in a direction of a thickness of a nickel film are formed". (emphasis added) These features are not shown or suggested by Kawakami et al., Weber et al. and Segawa et al. or any combination of these references.

Kawakami et al. relate to an electroless plated powder and a production process therefore (see page 1, lines 14-15 of the translation).

Kawakami et al. disclose the step of allowing a core material to trap noble metal ions, and then reducing the ions to carry the metal on the surface of the core material (see page 14, lines 19-24 and page 15, lines 5-7 of the translation).

Kawakami et al. also disclose the step of dispersing the powder of the core material in an aqueous suspension (page 16, line 11 - page 17, line 10 of the translation).

Kawakami et al. also disclose the step of adding at least two solutions constituting the electroless plating solution individually and simultaneously to the aqueous suspension to perform an electroless plating (see page 18, line 23 - page 19, line 6 of the translation).

Kawakami et al. do not disclose the steps of (II) dispersing the core particles in an initial thin film-forming solution

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

containing nickel ions, a reducing agent, and a complexing agent comprising an amine to prepare an aqueous suspension, and reducing the nickel ions to form initial thin nickel film on a surface of each of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core particles provided with the initial thin nickel films and the complexing agent to perform electroless plating so that columnar structures extending in a direction of a thickness of a nickel film are formed as claimed in independent claims 3, 16, 33 and 34.

Applicants respectfully submit that Experiment 2 of the Declaration under 37 CFR 1.132 filed on October 26, 2007 clearly proves that an initial thin film is not formed on the surface of the core powder by using the method described in Kawakami et al. because the reducing agent contained in the aged plating solution does not have a high reducing power sufficient to reduce metal ions. Therefore, Kawakami et al. do not teach, disclose or suggest the claimed steps (II) and (III) of the present invention.

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

In the office action, the Examiner believed that the Declaration under 37 CFR 1.132 filed on October 26, 2007 was insufficient to overcome the rejection based on Kawakami et al. because the Experiments described in the Declaration omitted claimed step (III). The Examiner also believed that the claimed step (III) was obvious over Kawakami et al. Also, the Examiner believed that Kawakami et al. taught that a fresh nickel ion-containing solution, a complexing agent solution and a solution of a reducing agent were added to the aged plating solution containing a dispersed core particles (see page 5, lines 10-12 of the office action).

Accordingly, applicants respectfully submit that Experiment 1 of the Declaration under 37 CFR 1.132 filed with this response discloses an additional experiment was prepared which added claimed step (III) using the aqueous suspension containing the core powder obtained from Experiment 2 of the Declaration filed on October 26, 2007.

It is clear from the result of Experiment 1 and Fig. 1 of the Declaration, that the method described in Kawakami et al. would not have been obvious to perform electroless plating for forming columnar structures extending in a direction of the thickness of the nickel film on the surface of the core particles as claimed in the present invention since no columnar structures

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

were formed. As discussed above, the present invention includes the unexpected results by providing a nickel film having the columnar structures as shown in Fig. 1 of the present invention where the heat resistance is high, and the conductivity of the plated powder is not really decreased even under high temperature conditions.

Specifically, the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 was measured with a following analysis method.

- 1) The wastewater of electroless plating was added to a triangle flask with stopper using 2 ml whole pipette.
 - 2) 20 ml of 6 mol hydrochloric acid solution was measured in a graduated cylinder, and it was added.
 - 3) 0.05 mol iodine standard solution was added using a 20 ml whole pipette.
 - 4) It was corked, and was shaken, and put it in a dark place for 30 minutes.
 - 5) The amount of sodium hypophosphite was estimated by titration using 0.05 mol sodium thiosulfate standard solution.
 - 6) 3 to 5 ml of starch indicator as an indicator was added.
- After these processes, the concentration of the sodium hypophosphite was calculated as follows: the concentration of the

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

sodium hypophosphorous acid (g/L) = [(the number of the titration of an empty experiment (ml)) - (the number of the titration of this experiment (ml)) x 2.65 x dilution magnification x F] (F: 0.05 mol - factor of sodium thiosulfate standard solution).

The result of the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 was less than 0.01 g/L. By the result of this experiment, it proves that sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 has a weak reducing property and it does not have a reducing property sufficient to reduce metal ions. Therefore, an electroless plating reaction was not carried out by the method described in Kawakami et al. Moreover, even though the claimed step (III) using the aqueous suspension containing the core powder obtained from Experiment 2 of the Declaration filed on October 26, 2007 was processed, it did not perform electroless plating forming columnar structures extending in a direction of the thickness of the nickel film on the surface of the core particles as claimed in the present invention in part because an initial thin film was not formed on the surface of the core powder by using the method described in Kawakami et al.

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

For these reasons, it is believed that Kawakami et al. do not show or suggest the present claimed features of the present invention. Applicants also submit that Weber et al. do not make up for the deficiencies in Kawakami et al.

Weber et al. relate to a substrate, a method of nucleation, a powder, and a method for metal plating (see column 1, lines 6-7). Glass substrates in the form of plates of glass or glass powder were nucleated with palladium and then coated with a layer of nickel/tungsten (see column 3, lines 49-52).

Weber et al. also disclose that in addition to the Ni/W alloy, layers including alloys such as Ni/Sn, Co/W and Co/Mo, a single metal such as Ni, Cu, Ag, Au and platinum metals or metal oxide can be applied (see column 5, line 45-48).

Weber et al. do not disclose the steps of (II) dispersing the core particles in an initial thin film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an amine to prepare an aqueous suspension, and reducing the nickel ions to form initial thin nickel film on a surface of each of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent, to the aqueous suspension individually and simultaneously, the aqueous suspension containing the core

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

particles provided with the initial thin nickel films and the complexing agent to perform electroless plating so that columnar structures extending in a direction of a thickness of a nickel film are formed as claimed in independent claims 3, 16, 33 and 34. (emphasis added)

In the office action, the Examiner disagreed with applicants' arguments regarding when the Weber et al. process was applied to the core particles using several different conditions, no continuous Ni metal coating was obtained. However, applicants respectfully submit that in fact, the Declaration filed on March 26, 2007 proves that when the Weber et al. process is applied to the core particles using several different conditions, no continuous Ni metal coating was obtained. The reasons why continuous Ni metal coating was not carried out in the electroless plated bath of Weber et al. are discussed below.

Applicants respectfully submit that Experiment 2 of the Declaration filed with this response proves that even though the nickel ion-containing solution and the reducing agent-containing solution were individually and simultaneously added to the aqueous suspension of Weber et al., a nickel metal was not deposited on the surface of the core particles. By the result of this experiment, applicants respectfully submit that an initial thin nickel film was not formed on the surface of the core powder

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

based on the method described in Weber et al. and therefore, the electroless plating reaction was not carried out on a low activity place which does not have initial thin film.

Also, applicants respectfully submit that electroless plating reaction in Weber et al. was not carried out because Gluconic acid is strongly chelated with Ni and W under a pH 9. In addition, applicants respectfully submit that electroless plating reaction in Weber et al. was not carried out because Ammonia works complexing agent under around pH 9 so that no continuous Ni metal coating was obtained. Further, no columnar structures were found in the experiment using the Weber et al. process.

Also, applicants respectfully submit that Weber et al., Kawakami et al. and none of the prior art references do not teach, suggest and disclose the steps of (II) dispersing the core particles in an initial thin film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an amine to prepare an aqueous suspension, and reducing the nickel ions to form initial thin nickel film on a surface of each of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent, to the aqueous suspension individually and simultaneously, the

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

aqueous suspension containing the core particles provided with the initial thin nickel films and the complexing agent to perform electroless plating so that columnar structures extending in a direction of a thickness of a nickel film are formed as claimed in independent claims 3, 16, 33 and 34. (emphasis added)

The present invention and the Declarations show that the columnar structures provide unexpected results. To achieve these unexpected results, the initial thin film is formed on the surface of the core particles in a process of the claimed step (II) by using an initial thin film forming solution. Then, the same kind of complexing agent used in the claimed step (II) is contained in the first solution in a process of the claimed step (III) for growing the film including columnar structure on the surface of the core particles.

Applicants respectfully submit that both Kawakami et al. and Weber et al. do not teach, suggest or disclose the claimed steps (II) such that the initial thin nickel film is formed on a surface of each of the core particles. Even though the Examiner believed that the claimed step (III) was obvious over Kawakami et al., applicants respectfully submit that none of the references teach, suggest or disclose using the claimed aqueous suspension containing the core particles provided with the initial thin nickel films. Therefore, it would not have been obvious to form

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

columnar structures extending in a direction of the thickness of a nickel film based on the method described in Kawakami et al. and Weber et al.

For these reasons, it is believed that Weber et al. do not show or suggest the present claimed features of the present invention. Applicants also submit that Segawa et al. do not make up for the deficiencies in Kawakami et al. and Weber et al.

Segawa et al. relate to apparatus for electroless plating and method for forming conductive film.

Segawa et al. disclose an apparatus for an electroless plating capable of suppressing a change of a plating liquid with time and carrying out electroless plating homogeneously and accurately, and provide a method for forming a conductive film (abstract).

Segawa et al. do not disclose the steps of (II) dispersing the core particles in an initial thin film-forming solution containing nickel ions, a reducing agent, and a complexing agent comprising an amine to prepare an aqueous suspension, and reducing the nickel ions to form initial thin nickel film on a surface of each of the core particles; and (III) adding a first solution, which contains a nickel ion-containing solution and the complexing agent, and a second solution, which contains a reducing agent, to the aqueous suspension individually and

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

simultaneously, the aqueous suspension containing the core particles provided with the initial thin nickel films and the complexing agent to perform electroless plating so that columnar structures extending in a direction of a thickness of a nickel film are formed as claimed in independent claims 3, 16, 33 and 34.

It is therefore respectfully submitted that Kawakami et al., Weber et al., and Segawa et al., individually or in combination, do not teach, disclose or suggest the presently claimed invention and it would not have been obvious to one of ordinary skill in the art to combine these references to render the present claims obvious.

New independent claim 40 has been added in the application. Applicants respectfully submit that new independent claim 40 is similar to claim 1 and also recites "(II) dispersing the core particles in an initial thin film-forming solution containing 1) nickel ions, 2) a reducing agent including one of sodium hypophosphite, sodium borohydride, potassium borohydride, dimethylamine borane, hydrazine and formalin, and 3) a complexing agent comprising an amine to prepare an aqueous suspension, and wherein said step of dispersing the core particles in an initial thin film-forming solution containing nickel ions includes adjusting the reducing agent in the initial thin film-forming

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

solution in the range between 4×10^{-4} and 2.0 mol/l so that the nickel ions are reduced to form initial thin nickel film on a surface of each of the core particles". Applicants respectfully submit that these claimed features of new independent claim 40 are different from Kawakami et al, Weber et al., Segawa et al. or any combination of these references.

The present invention discloses that examples of reducing agents which may be used include sodium hypophosphite, sodium borohydride, potassium borohydride, dimethylamine borane, hydrazine, and formalin (see page 10, line 28 - page 11, line 2 of the specification. Also, the present invention discloses that the concentration of the reducing agent in the initial thin film-forming solution is preferably 4×10^{-4} to 2.0 mol/l and more preferably 2.0×10^{-3} and 0.2 mol/l (see page 12, lines 15-17 of the specification).

Specifically, the minimum concentration of sodium hypophosphite is calculated as follows: the minimum concentration of the sodium hypophosphite (g/L) = 4×10^{-4} [mol/l] x 105.99 (Molecular Weight of the sodium hypophosphite). The result of the minimum concentration of sodium hypophosphite is 0.042 (g/L).

Also, the minimum concentration of sodium borohydride is calculated as follows: the minimum concentration of the sodium borohydride (g/L) = 4×10^{-4} [mol/l] x 37.83 (Molecular Weight of

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

the sodium borohydride). The result of the minimum concentration of the sodium borohydride is 0.015 (g/L).

Also, the minimum concentration of potassium borohydride is calculated as follows: the minimum concentration of the potassium borohydride (g/L) = 4×10^{-4} [mol/l] x 53.94 (Molecular Weight of the potassium borohydride). The result of the minimum concentration of the potassium borohydride is 0.022 (g/L).

Also, the minimum concentration of dimethylamine borane is calculated as follows: the minimum concentration of the dimethylamine borane (g/L) = 4×10^{-4} [mol/l] x 58.92 (Molecular Weight of the dimethylamine borane). The result of the minimum concentration of the dimethylamine borane is 0.024 (g/L).

Also, the minimum concentration of hydrazine is calculated as follows: the minimum concentration of the hydrazine (g/L) = 4×10^{-4} [mol/l] x 32.05 (Molecular Weight of the hydrazine). The result of the minimum concentration of the hydrazine is 0.013 (g/L).

Also, the minimum concentration of formalin is calculated as follows: the minimum concentration of the formalin (g/L) = 4×10^{-4} [mol/l] x 30.03 (Molecular Weight of the formalin). The result of the minimum concentration of the formalin is 0.012 (g/L).

.
Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

On the other hand, as described above (see pages 24-25 of this amendment), the result of the concentration of sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 was less than 0.01 g/L. By the result of this experiment, it proves that sodium hypophosphite in the wastewater of electroless plating after use in Experiment 1 of the Declaration filed on October 26, 2007 has a weak reducing property and it does not have a reducing property sufficient to reduce metal ions. Therefore, the nickel ions were not reduced to form an initial thin nickel film on the surface of each of the core particles by the wastewater. Also, none of the other prior art references show this feature.

Applicants respectfully submit that it is critical to adjust the reducing agent in the initial thin film-forming solution to a range where the nickel ions are reduced to form initial thin nickel film on a surface of each of the core particles. This critical concentration range has been included in new claim 40. Therefore, allowance of new independent claim 40 is also respectfully requested.

Also, new dependent claim 41, which depends from new independent claim 41, has been added in the application. Applicants respectfully submit that new dependent claim 41

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

recites the step of "dispersing the core particles in an initial thin film-forming solution containing nickel ions includes adjusting the reducing agent in the initial thin film-forming solution in the range between 2.0×10^{-3} and 0.2 mol/l".

Applicants respectfully submit that this additional feature of new dependent claim 41 also defines over the prior art of record.

Specifically, the minimum concentration of sodium hypophosphite is calculated as follows: the minimum concentration of the sodium hypophosphite (g/L) = 2.0×10^{-3} [mol/l] x 105.99 (Molecular Weight of the sodium hypophosphite). The result of the minimum concentration of sodium hypophosphite is 0.21 (g/L).

Also, the minimum concentration of sodium borohydride is calculated as follows: the minimum concentration of the sodium borohydride (g/L) = 2.0×10^{-3} [mol/l] x 37.83 (Molecular Weight of the sodium borohydride). The result of the minimum concentration of the sodium borohydride is 0.075 (g/L).

Also, the minimum concentration of potassium borohydride is calculated as follows: the minimum concentration of the potassium borohydride (g/L) = 2.0×10^{-3} [mol/l] x 53.94 (Molecular Weight of the potassium borohydride). The result of the minimum concentration of the potassium borohydride is 0.11 (g/L).

Also, the minimum concentration of dimethylamine borane is calculated as follows: the minimum concentration of the

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

dimethylamine borane (g/L) = 2.0×10^{-3} [mol/l] x 58.92
(Molecular Weight of the dimethylamine borane). The result of
the minimum concentration of the dimethylamine borane is 0.12
(g/L).

Also, the minimum concentration of hydrazine is calculated
as follows: the minimum concentration of the hydrazine (g/L) =
 2.0×10^{-3} [mol/l] x 32.05 (Molecular Weight of the hydrazine).
The result of the minimum concentration of the hydrazine is 0.064
(g/L).

Also, the minimum concentration of formalin is calculated as
follows: the minimum concentration of the formalin (g/L) = $2.0 \times$
 10^{-3} [mol/l] x 30.03 (Molecular Weight of the formalin). The
result of the minimum concentration of the formalin is 0.06
(g/L).

Applicants respectfully submit that the narrower range set
forth in claim 41 is also critical for forming the initial thin
nickel film on the surface of each of the core particles.
Therefore, allowance of new dependent claim 41 is also
respectfully requested.

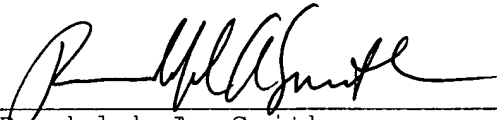
In view of foregoing claim amendments and remarks, it is
respectfully submitted that the application is in condition for
allowance and an action to this effect is respectfully requested.

Preliminary Amendment
Application No.: 10/820,024
Reply to Office Action dated November 9, 2007
July 9, 2008

If there are any questions or concerns regarding the amendments or these remarks, the Examiner is requested to telephone the undersigned at the telephone number listed below.

Respectfully submitted,

Date: July 9, 2008



Randolph A. Smith
Reg. No. 32,548

SMITH PATENT OFFICE
1901 Pennsylvania Ave., N.W.,
Suite 901
Washington, DC 20006-3433
Telephone: 202/530-5900
Facsimile: 202/530-5902
Oyamada070908